



# A review of China's carbon trading market

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## ABSTRACT

One of the greatest constraints currently affecting China's economic development is climate change, with its associated restrictive conditions. Consequently, the application of appropriate actions to conserve energy and reduce emissions features centrally in China's core national development goals and development policies. These goals not only pose significant challenges and opportunities, but they also entail an important innovation. Under the framework of the Kyoto Protocol, the carbon trading market has emerged at a historic moment as an important measure for conserving energy and reducing emissions. Given the continuous development of the international carbon trading market over the last decade, China is also attempting to develop its own carbon trading market to further contribute to energy conservation and emissions reduction. Based on an analysis of the current situation of China's carbon trading market, relevant policy suggestions are offered here for its improvement, with the aim of providing guidelines for reducing carbon emissions, which are of mounting concern.

## 1. Introduction

Sustainable growth of the Chinese economy entails a corresponding rise in energy consumption. China's carbon emissions per head of population exceeded those of the European Union (EU) for the first time in 2013, according to the global carbon emissions data released by Global Carbon Program which is an organization seeks to quantify global carbon emissions [1,2]. Each person in China produced 7.2 t of carbon dioxide on average, compared with 6.8 t in Europe citing a study by the University of Exeter's College of Engineering, Mathematics and Physical Sciences [1,2]. In 2014, total global carbon dioxide emissions amounted to almost 35.5 billion tons, with China's emissions ranked highest, worldwide, at 9.76 billion tons [3,4].

The government of China has released the country's 13th Five-Year Plan (2016–2020) for economic development. This document takes stock of recent changes in the Chinese economy and energy systems that have occurred since the turn of the millennium and projects the likely trajectory of Chinese emissions over the next decade [4–7]. The current Plan establishes basic requirements and goals in areas such as energy consumption and environmental quality up to 2020. In particular, it emphasizes mandatory targets instituted over the past decade to reduce energy use, curb air pollution, and promote the development of non-fossil energy [8]. The Plan calls for an 18% reduction in carbon intensity, which is a measure of how much carbon dioxide is emitted per unit of gross domestic product. This target is slightly higher than the 17% target set in 2011 [5–8]. The latest Plan also seeks to limit the country's total energy use, with the aim of capping total energy use

equivalent to 5 billion tons by 2020 [5,7].

The carbon-constrained goal of the Chinese government is to achieve a peak in 2030 for carbon dioxide emissions and a decrease of 60–65% in carbon dioxide emissions per unit GDP compared with the amount of emissions in 2005 [6–10]. Further, the government aims to increase the share of non-fossil fuels in primary energy consumption to around 20% and to increase the forest stock volume by around 4.5 billion cubic meters compared with 2005 levels [6–10]. The Paris Agreement was formulated in December 2015 during the 21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris, France. On April 22, 2016, China signed the Paris Agreement, and promised to take steps proactively to reduce its domestic greenhouse gases and to strengthen international cooperation on the climate change issue. These actions reflect China's commitment and responsibility relating to global climate governance [8–10].

The question of how to cope with mounting pressure to address the increasingly alarming situation regarding emissions has gained considerable attention [11–13]. China is currently undergoing a major structural transformation associated with the implementation of a new development model that is more sustainable and inclusive than the current one. Energy-saving emissions reduction is not only a necessary requirement for countering climate change, but it is also critical for accelerating a shift in China's current model of economic development toward low-carbon and green development [11–13].

Under the framework of the Kyoto Protocol, the carbon trading market has emerged at a historic moment as an important measure for

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saving energy and reducing emissions. On May 9, 1992, the UNFCCC emerged as the outcome of difficult negotiations conducted between member countries of the United Nations Intergovernmental Panel on Climate Change [12]. At the third conference of the parties to the UNFCCC (COP3), the “Kyoto Protocol” (referred to as the “Protocol”) was adopted in December 1997 in Kyoto, Japan. Under the Protocol, the mechanism of the market was conceived as the new pathway for reducing greenhouse gas emissions. Accordingly, carbon dioxide emissions are conceptualized as a kind of tradable commodity, with the carbon trading market referring to the carbon emissions trading market, or to a real carbon credit market that centers on carbon emissions trading [11–14].

To promote the development of green and low-carbon development, and to effectively deal with global climate change, the Chinese government has implemented a number of measures aimed at controlling greenhouse gas emissions [15,16]. The most remarkable achievement has been the development of the China's carbon trading market in recent years [11–13]. Carbon trading is being applied as a market mechanism for reducing China's carbon dioxide emissions and mitigating climate change. This paper presents a review of the development and status quo of China's carbon trading market. The problems facing China's carbon trading markets are identified and policy recommendations are offered for unifying the national carbon trading market.

Thus, our aim is to review the evolving process of developing China's carbon trading market to date and to offer suggestions for optimizing this market. The remainder of the paper is organized as follows. Section 2 presents an outline of the development of the China's carbon trading market. In Section 3, the current situation of the China's carbon trading market is discussed. In Section 4, challenges facing the China's carbon trading market are explored, and suggestions are offered on how these challenges can be met. Last, Section 5 presents the conclusions of the study.

## 2. Development of the China's carbon trading market

Carbon trading is an environmental management tool for controlling carbon emissions [17]. By putting a price on CO<sub>2</sub> and allowing emitters to buy and sell reduction obligations, an emissions trading scheme (ETS) is implemented. One party that generates more emissions could purchase the right to emit carbon from another party that generates a lower level of carbon emissions. The buyer can then use the emission reductions to mitigate the greenhouse effect and achieve the goal of reducing emissions [17,18]. At present, the major international carbon emissions trading markets are the EU Emissions Trading System (EU ETS), the Regional Greenhouse Gas Initiative (RGGI) implemented in the United States, California's Cap-and-Trade Program, the Tokyo Cap-and-Trade Program, the New Zealand Emissions Trading Scheme, and South Korea's carbon trading program. Among them, the EU ETS has the largest trading volume in the world, and it accounts for about 90% of the global carbon trading scale [17,18]. The first official document in China to mention carbon trading was “Decision of the State Council on Accelerating the Fostering and Development of Strategic Emerging Industries” released in October 2010 [19]. Carbon trading also features in the country's 12th Five-Year Plan (2011–2015) and other documents. The development process of China's carbon trading market has been gradual, commencing with a “The Work Plan for Greenhouse Gas Emission Control during the 12th Five-Year Plan Period” issued at the end of 2011 [20]. Such initiatives were aimed at exploring the establishment of a carbon emissions trading market in China [20–25].

The launching of carbon trading market pilots in China is indicative of the development status of the China's carbon trading market [17]. On October 29, 2011, to fulfill the requirements for gradually establishing a domestic carbon emissions trading market during the period of the 12th Five-Year Plan, the office of the National Development and Reform Commission (NDRC) issued a “Notice on Carrying out the Carbon

Emissions rights Trading Pilot Work”. This notice announced the agreement to initially conduct carbon emissions trading pilots in Beijing, Tianjin, Shanghai, Chongqing, Hubei Province, Guangdong Province and Shenzhen [21]. The sites selected by the NDRC for the pilots are highly typical. These areas span the eastern coastal areas, extending to the central region. They encompassed an area of 48 million square kilometers, with a total population of 0.262 billion, a total GDP of 15.5 trillion Chinese Yuan (CNY), and energy consumption amounting to 887 million tons of standard coal. In addition, “Interim Measures for the Administration of Voluntary Greenhouse Gas Emission Reduction Transactions” and “Interim Measures for the Administration of Carbon Emission Permit Trading” were issued in 2012 and 2014 respectively to guide the carbon trading market in pilots and to promote the establishment of a national carbon emission trading market [22,23].

In 2014, online transactions had been initiated within all seven pilots according to statistics provided by the NDRC. More than 1900 companies and services were involved in the pilots, and the total amount of their allocation of carbon emissions was about 1.2 billion tons. Up to the end of 2015, the seven pilot carbon markets had achieved a cumulative turnover of nearly 80 million tons valued at over 2.5 billion CNY.

From a macroscopic perspective, the pattern of trading behavior among market participants demonstrated a significant shift in 2015 [24]. The compliance rate in 2015 showed a marked increase compared with the rate during the same period in 2014. In 2014, only the Shanghai pilot achieved a compliance rate of 100%, whereas in 2015, Beijing, Guangdong, Shanghai, and Hubei also achieved a compliance rate of 100%. The market also expanded in 2015, compared with the size of the market during the previous period. This expansion encompassed the growth in the pilot trading markets and a significant increase in the overall trading volume [25–29]. In 2015, Hubei and Chongqing pilot markets performed the first trades in the evolving China's carbon market, resulting in the participation of 400 more enterprises in the pilots compared with the number of participants in 2014. The Chinese Certified Emission Reduction (CCER) was adopted as a form of offsetting carbon emission quotas, and its registration system was officially launched in 2015. The seven pilots successively promulgated their respective management approaches for offsetting carbon. Because of differing provisions within each pilot relating to the CCER proportions allocated, project category, project source, method of reducing displacement output time, and offset limits, the CCER policy on market entry in the different pilots has entailed varying thresholds. In the pilot areas with less restrictive conditions for offsetting rules, such as Shanghai and Beijing, CCER trading performance is more apparent than it is in other provinces and cities. The CCER policy on market entry has promoted the mobility of the carbon market, but it has simultaneously resulted in a drop in market prices, with an evident decline in the quota price of each pilot market in 2015. Of these markets, the Shanghai market had the largest amount of CCER performance, with the greatest change in the carbon quota price. The daily and monthly average prices were lowest in Shanghai, at 9.5 CNY/ton and 15.52 CNY/ton, respectively. The involvement of a large number of institutional investors in the carbon trading market could further strengthen its vitality.

In addition to the existing seven carbon emissions trading centers, several domestic participants in the carbon market have begun to explore carbon trading mechanisms. For example, Beijing Environment Exchange and Shanghai Environment and Energy Exchange have launched services relating to carbon trading [25].

In recent years, the seven carbon trading pilots have experimented with different policy ideas and distribution methods [24]. They have introduced regulations and enterprises education and have implemented surveys on the data situation. Moreover, they have initiated transactions and performance assessments and have developed an off-setting mechanism.

### 3. The current status of the China's carbon trading market

On January 11, 2016, the NDRC issued a “Notice on Doing a Good Job in the Key Work of Launching the National Carbon Emissions Trading Market”. This aimed at promoting the development and co-ordination of the carbon emissions trading system to ensure the implementation of national carbon emissions trading market in 2017 [30].

In 2016, a total of 2391 enterprises and units had been brought on to the seven pilot carbon trading platforms, and the total amount of allocated carbon emission quotas was about 1.2 billion tons. Compared with the carbon trading volume of the EU ETS, the volume of China's carbon trade remains small in 2016. However, China's carbon trading system is the second largest, worldwide, encompassing key industries, such as steel, power, chemicals, construction, paper and non-ferrous metals [31–35]. Up to December 31, 2016, the turnover of the seven pilot carbon markets was 160 million tons valued at close to 2.5 billion CNY [24,30].

The establishment of a platform for carbon emissions trading in Fujian Province was proposed under “The Implementation Plan for the National Ecological Civilization Pilot (Fujian)” [36]. Accordingly, China's eighth pilot carbon trading market was launched in Fujian at the end of December 2016. Based on lessons derived from the experiences of the other pilots, nine industries, namely electrical power, steel, chemicals, petrochemicals, nonferrous metals, building materials, civil aviation, papermaking, and ceramics were integrated into the Fujian carbon trading market. This market has subsequently taken the lead among the pilots, as evidenced by the adoption of national standards and guidelines for carbon verification in this pilot. Further, the quota allocation methods of three industries, namely power, cement, and electrolytic aluminum are almost identical to the latest released national quota allocation methods. In addition, Fujian has established a forestry-based carbon sequestration transaction model and has developed a carbon market with Fujian characteristics.

The total volume of carbon traded in the Fujian market was about 4.0167 million tons, and the transaction value was about 105.62 million CNY at the end of July 7, 2017. Thereinto, the carbon quota was 3.0551 million tons, with the transaction value amounting to 86.47 million CNY. The CCER volume was 0.687 million tons, and the transaction value was 13.9 CNY. Fujian Forestry Carbon Sequestration (FFCER) sold 274,000 t, and the transaction value was 5.25 million CNY. Among the eight China's carbon trading pilot markets, the Fujian market accounted for the greatest total volume of carbon emissions.

On June 6, 2017, the NDRC announced that China would initiate a national carbon emissions trading market in 2017. The EU has been operating the world's largest cap-and-trade system since 2005. Similar systems have been implemented in California as well as in a group of northeastern states in the United States. The China's trading scheme is expected to encompass roughly half of the country's emissions, including those originating from electricity generation and from energy-intensive industries. Peter Reitz, the CEO of the European Energy Exchange (EEX), stated that following its anticipated launch in 2017, the China's carbon market was expected to account for 4 billion tons of carbon dioxide equivalent [6,34]. This volume is twice that of the European carbon market, and would become the largest carbon trading system in the world. Thus, the China's national carbon market, when it launches, will transform the global carbon market [34–37].

The first stage of developing a national carbon market will encompass eight major industries. These eight industries are petrochemicals, chemicals, building materials, iron and steel, nonferrous metals, paper making, power, and aviation. They are also the enterprises with energy consumption amounts to 10,000 or more tons of standard coal. Based on a preliminary calculation, more than 7000 enterprises will enter the national carbon trading market at the first stage. The total volume of their carbon emissions will range between 4 billion and 5 billion tons, which accounts for about 50% of China's emissions. However, we should take a rational view of the trend that China would

be the world's largest carbon market. This is because China's global rankings for its total economic output and carbon emissions are second and first, respectively.

The EU's carbon market has been operational over a long duration and is relatively mature. By contrast, China's market has been operational for just a short time and is immature. Compared with developed countries, China is still lagging behind in terms of the development of its carbon trading market [37]. It has not yet formed a unified national carbon trading market, and its trading efficiency and market activity are relatively low. Moreover, the legal system governing the carbon trading market is not yet fully developed. Because of the unevenness of China's economic and social development, the industrialization and marketization of carbon trading in China are far from enough, and the current situation is not conducive to the further integration of its markets into the international carbon trading market.

### 4. Suggestions for optimizing China's carbon trading market

With the emergence of its carbon trading market, China is now the main seller of carbon emissions and has considerable potential to achieve carbon emission reduction [38]. A long-term perspective indicates that if China succeeds in making good use of the carbon trading market, this will not only yield tangible economic benefits, but will also contribute to improving energy efficiency and optimizing the structure of energy utilization. Valuable experiences and lessons in areas such as legislative protection, technologies, selection criteria, historical data processing, quota allocation, verification management, and enterprises participation have been acquired and can be applied to optimize China's carbon trading markets. These markets also face challenges relating to transaction efficiency, market supervision, relevant legislation, and talent recruitment [39–43]. Moreover, it is essential to address areas of uneven development relating to the current carbon trading market. Given that the Chinese economy's overall emissions are the highest globally, a substantial shift in China's policies relating to its carbon trading system is now essential. Optimization of China's carbon trading market and the establishment of linkages between the pilot markets and the national carbon market are prerequisites for achieving the ultimate goal of establishing a unified national carbon emission market. Therefore, several recommendations are offered here for optimizing the China's carbon trading market.

#### 4.1. Strengthening the carbon trading market system

Carbon trading markets in China have been moving forward. From a results perspective, the eight major carbon trading pilots encompassing three provinces and five cities have been completed. During the implementation of the eight pilot carbon markets in recent years, a substantial body of valuable experience has been amassed for the construction of the national carbon market in total control, quota allocation, emissions data detection, report and verification (MRV) etc. [38,40]. Thus, accumulated experience and knowledge provides a solid foundation for the development of a national carbon market. In terms of transactions, the eight carbon trading platforms have been engaged in active efforts to explore and compile useful practical experience and data.

However, several aspects require improvement to strengthen the development of the carbon trading market system. These areas include unifying carbon trading standards, improving access and transparency of information, and improving the liquidity of the carbon trading market.

##### 4.1.1. Unifying standards for the carbon trading market

Trading in carbon quotas and other carbon products requires a professional and efficient trading platform. This platform plays a central role in negotiations conducted between the two parties, leading to the signing of a carbon-trading contract and subsequent trade in carbon

products. However, unified standards for examining approval rights and the access system for China's carbon emissions trading are currently lacking.

This problem needs to be resolved before China launches a national carbon trading market, as it impacts significantly on the mobility and vitality of the carbon trade. Financial institutions and exchanges should cooperate fully with the government to unify carbon trading standards. Such cooperation entails strengthening communication and coordination with other trading platforms in areas such as integration of carbon trading standards and market circulation [44–47]. Thus, key requirements are unifying carbon market trading standards as quickly as possible, building a carbon quota cross-platform, and developing inter-regional trading.

#### 4.1.2. Enhancing transparency within the carbon trading market

Carbon trading, which is a market mechanism, must adhere to fair, open, and transparent market principles. In the absence of transparent and widely accessible market information, the carbon market price discovery could fail and market participants cannot make fine trading decisions.

Further improvements in information transparency are required in China. Although implementation of carbon trading schemes, management measures, and other policy tools have been announced within most of the pilots, key data on the enterprises' control of exhaust emissions and the total number of quotas and their allocation should also be made publicly available [45,47]. Access to sufficient and relevant information can ensure effective participation of enterprises in carbon market transactions.

#### 4.1.3. Improving the liquidity of the carbon trading market

We observed that the pilot areas with less restriction for offsetting rules in carbon trading, were associated with higher carbon trade volumes. To a certain extent, the carbon trading market could be stimulated and vitalized by a comparatively relaxed market environment. However, market prices could also become depressed as a result of an influx of key players into the market. This could dampen the enthusiasm of enterprises to engage in transactions, especially during the initial stage of developing a carbon trading market in China.

Moderate liquidity is thus critical for the formulation of reasonable prices and for facilitating enterprises to improve their efficiency and reduce their costs. If the price of the carbon quota is too high or too low, then the enterprise is unable to reduce carbon emissions at a minimum cost. During the carbon pilot stage, the China's carbon trading market has been mainly based on carbon quota trading [45]. However, with the development of a market mechanism, this is an opportune time for introducing diverse carbon financial instruments. The performance of these instruments would greatly improve the liquidity and activity of the carbon trading market. Banks and other financial institutions should be encouraged to introduce carbon insurance, carbon futures, carbon funds, and other carbon financial instruments and to introduce more low-carbon investment and financing policies [45–51].

There should be a greater focus on the tightness of the total amount of quotas, diversification of market participants, trading varieties, and policy continuity to strengthen investors' confidence in the market and emission reduction policies. Attending to these issues would help to promote the market's vitality and liquidity.

#### 4.2. Accelerating the development of professional talent and teams in carbon trading

Developing and strengthening professional talent and teams to engage in carbon trading are critical requirements. Imbalances in the levels of understanding and proficiency of inspectors relating to the implementation of a verification mechanism within the same or different agencies will result in different verification standards [52–56]. These variations will also affect the accuracy of the data. If the companies that

regulate emissions are not familiar with the basic principles and rules of the carbon trading market, then they will be unlikely to take the initiative in managing carbon assets. They may adopt a passive approach for engaging with possible outcomes that may result in energy saving but raise the cost of emissions reduction. At present, China's carbon trading market transaction parties are decentralized, bargaining power is weak, and the overall level of the trading platform is low. Moreover, the process of configuring software and hardware has not been completed [24,37]. Further, data on prices available to participants in the China's carbon trading market are highly fragmented and of relatively low accuracy. Therefore, a significant number of professionals need to be recruited and trained to ensure the efficiency and professionalism of all types of institutions involved in the carbon trading market.

More enterprises should be encouraged to provide services for the carbon trading market. On the one hand, the involvement of such enterprises would enable the provision of professional and efficient services for the carbon trading market. On the other hand, low-carbon economic benefits would be extended to a greater number of enterprises. Intermediary agencies, third-party certification agencies, verification agencies, and information service providers engaged in exchanges in the carbon trading market constitute a platform for carbon trading [53–56]. These agencies participate in carbon market transactions and generate profits. They also approve carbon emissions reduction projects, verify data, and provide effective information services for investors and other participants. The government and service organizations should seek to develop the skills of qualified market professionals through the provision of education and training courses on carbon trading, and institutions of higher education should be encouraged to develop carbon trading majors [24,25]. There is also a need for more intermediary organizations and consulting firms focusing on environmental issues.

With the support of professional organization operation, investors will occupy the initiative of decision-making. In addition, when carbon fund and other professional institutions are involved, the degree of symmetry of market information exchange will be higher, and the transaction will be more efficient [39]. Specialized agencies could provide information services, develop environmental and financial services, and regulate carbon financing. This would ensure that the quality of the transactions remain consistently high and would promote the efficiency of the China's carbon trading market.

#### 4.3. Overall planning, coordination, and balanced development of regions

There are significant differences in the economic structures and levels of economic development of the areas in which the eight pilots are located, which extend across the eastern, central, and western regions of China. The design of the carbon trading system of each area evidences regional features that correspond to the differing economic characteristics of each area [24,33,57]. Thus, the design of the system in Shenzhen is market-oriented, while the design of the Hubei system emphasizes market liquidity, and the designs of the Beijing and Shanghai systems target performance management. Policies implemented in Guangdong Province demonstrate a lack of continuity. In Chongqing, an independent reporting mode relating to enterprise quota allotment has been designed, leading to a significant surplus quota and “cold” transactions in the carbon market [33]. All of these models offer rich experience and valuable lessons. However, extending methods for developing markets that have been applied in the pilots to the entire country inevitably raises a number of problems. These problems include uneven development of regions, a tendency toward market fragmentation, and an environment that is not conducive to form a unified and healthy national market. Consequently, an approach that emphasizes the gradual extension of pilot methods across the country is necessary.

There are marked regional differences in China, requiring adjustments in the regional adjustment coefficient in terms of regional allocations and the allocation of emissions reduction tasks. The offsetting

mechanism could be applied to guide investments in the clean production project in less developed areas. The application of this method would not only promote green and low-carbon development in these less developed areas, but it would also contribute to poverty alleviation by integrating ecological compensation into the carbon trading market.

Economic imbalances between regions are reflected in differing admission criteria and trading rules among the pilots, prompting the design of diverse trading mechanisms [57,58]. Especially in developing regions where heavy industry is emphasized, the government should extend more policy support through the provision of capital, technology, and carbon tax concessions and by encouraging enterprises to engage in voluntary reduction of emissions. Thus, to achieve a unified market, the Chinese government should design unified trading criteria that are applicable to diverse regions, while fully considering regional imbalances [59]. Through the provision of attractive incentives, enterprises can be encouraged to engage in market competition, and carbon emission reduction can be promoted. To promote the formation and development of a unified national market, efforts should be made to stimulate market vitality in developing areas and to connect these markets to those in more developed areas as soon as possible.

#### 4.4. Establishment of a strong regulatory system for the carbon trading market

The most significant problem encountered in the eight pilots has been the lack of national-level legislation. By contrast, sound laws and regulations have been implemented within the EU ETS as a guarantee of carbon trading. Among the eight carbon trading pilots, only the ones in Shenzhen and Beijing have adopted legislation on carbon trading formulated by the local people's congress in each of these respective areas. Management measures relating to carbon trading have been issued through government orders within the pilots implemented in Shanghai, Guangdong, Tianjin, Hubei and Chongqing. However, these orders come under local government regulations and have weak legal binding power [33,58]. In line with the frameworks of the pilot implementation plans and management measures, technical policy documents, such as carbon emissions trading rules and Monitoring, Reporting, and Verification guidelines (MRV), have been developed for all of the pilots. However, these have not been framed as laws and regulations. In addition, the technical details, including those for the quota allocation scheme, require further improvement.

The NDRC has formally promulgated the “national carbon emissions trading management approach”, which provides a basic institutional guarantee for launching the national carbon trading market. However, the regulatory system and laws governing trade in carbon emissions in China are still imperfect. There is also an absence of legal documents specifying carbon trading methods. The rights of carbon trading intermediaries and service agencies are not defined, while the rights and obligations of participants in the carbon trading market have not been clarified [59]. All of these issues require urgent resolution within the legislative system established for the China's carbon trading market.

Compared with the carbon trading markets in developed countries and regions such as the United States and Europe, China's carbon trading market does not yet have an adequate supervisory system. A special unified market regulator has not been instituted. The regulatory authority of carbon trading market is both the maker of the game rules and the implementer, which is not conducive to the establishment of an effective regulatory coordination mechanism. A special regulatory department should be established to supervise the market effectively. In addition, the means of punishment for enterprises are single. Consequently energy conservation and emissions reduction do not receive sufficient attention from enterprises. A scientifically grounded and acceptable mechanism for settling disputes has not yet been established. As a result, the risk of default within carbon market transactions remains unaddressed.

The China's carbon trading market is a typical policy-oriented

market. Successful market operations are grounded in a sound regulatory system entailing effective policies and laws. Thus, a sound legal and regulatory system should be in place to promote smooth operations of the prospective national carbon trading market.

Thus, on the one hand, strong legislation is required for the carbon market, and relevant laws and regulations should be promulgated as soon as possible. In particular, the rights and obligations of carbon trading parties, trading methods and rules, dispute resolution mechanisms, penalties for violating the law, and the legal rights of enterprises should be stipulated clearly [60–64]. The responsibilities, rights, and interests of all parties engaged in the carbon market need to be clarified and laws and regulations need to be enacted to provide guarantees for carbon trading. The government should take the strategic significance of carbon emissions reduction into account. It is necessary to increase the content of the low-carbon economy in laws related to energy, environmental protection, and resource management and to promote the development of a national legal system to regulate the transformation process to achieve a low-carbon economy [64–66]. We recommend the publication and dissemination of national-level laws and regulations for addressing climate change and improving the system for managing climate change. In the absence of strong legislation, considerable difficulties will hinder follow-up efforts.

On the other hand, there is a need to strengthen the supervisory mechanism and performance management. In the long run, a supervisory mechanism should be established for the carbon emissions trading market. Moreover, a special regulatory department could be instituted to supervise the carbon emissions trading market [24,59]. Further, the establishment of a comprehensive regulatory system for addressing carbon trading market risks, controlling illegal operations, and maintaining normal procedures of carbon emissions trading should be explored. Efforts should be made to promote multilateral participation involving collaborations between the government, service organizations, and enterprises in the operation of the legal supervisory mechanism within the carbon trading market. The government should play a coordinating and leading role in promoting the market through macroscopic policy planning and supervision. However, it should not seek to directly control this market. Efforts should also be made to strengthen supervisory and regulative capacities relating to carbon emissions. For example, the time node of the MRV and the time node of performance adjustment should be clearly defined, and the provisions of third-party verification should be elaborated. Measures should be formulated to prevent any company or individual from being able to manipulate carbon market trading prices. A last set of recommendations entails strengthening performance management and imposing more stringent penalties for enterprises that fail to perform adequately.

## 5. Conclusions

Whether or not China succeeds in assuming a central position at the forefront of global development in the coming decades will largely hinge on its ability to adapt to low-carbon economic development and its efforts to establish a carbon trading market. Within the overall process of developing a China's carbon trading market, the initial phases of implementing pilots and designing a carbon trading market mechanism have been successfully completed. Commencing from 2011, carbon emissions trading pilots have been implemented in Beijing, Tianjin, Shanghai, Chongqing, Hubei Province, Guangdong Province, Shenzhen, and Fujian Province. It also aims to build a national carbon emissions trading market in 2017.

Up to now, China has achieved remarkable results in terms of the volume and performance. Although there is considerable potential for developing this market, there are significant gaps in terms of the efficiency of transactions, market supervision, the development of relevant legislation, and talent requirements. More attention should be focused on the issue of uneven development within the current carbon trading market. The pilots provide accumulated experience that can be assessed

to determine whether application of the theory of carbon trading, which is foreign to China, will be successful in this country. Currently, the critical question is how to link the pilot markets to the national carbon market to achieve the ultimate goal of establishing a unified national carbon emissions market.

Several important policy implications have emerged from our review in relation to the optimization of China's carbon trading market. First, China needs to take action to improve its carbon trading market system and formulate unified trading and market access standards. Second, regional development needs to be coordinated and balanced, with a focus on developing professional talent and service teams. Last but not least, China need to improve the relevant legal system construction. In conclusion, China should establish a unified, efficient, regulated, and supervised carbon trading market that can be effectively integrated into the international market, and achieve energy-saving emission reduction and green development eventually.

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